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ISOTOPIC FRACTIONATION OF WATER

When water is subjected to electrolysis an isotopic fractionation takes place, the evolved hydrogen being richer in the H^1 isotope and the evolved oxygen richer in the O^{16} isotope than is the water from which they are evolved. If the gases resulting from the electrolysis of water are recombined, the water produced has a lower density than the water from which they were evolved. The residual water grows progressively more dense as the electrolysis proceeds, owing to the increasing concentration of the H^2 isotope of hydrogen, and to a less extent also of the O^{18} isotope of oxygen. In a study of this subject at the Bureau, as reported in Research Paper No. 601, in the October number of the Bureau of Standards Journal of Research, curves illustrating the efficiency of the fractionation process are given. Substantially pure H^2, pure H^1, and pure O^{18} can be obtained by this fractionation process. The heavy water obtained by the process has a higher freezing point, a higher boiling point, and a lower refractive index than normal water. Isotopic fractionation of water by distillation and by adsorption has also been successfully carried out. A differential pycnometer method for measuring specific gravity, accurate to 1 part in a million, is described.

THERMAL EXPANSION OF COLUMBIUM

In the correction to this item (which was originally published in Technical News Bulletin No. 196), on page 96 of Technical News Bulletin No. 197, the equation, Lt should read L_t; in the statement immediately following the equation L_2 should read L_t; and +135° C should read +305° C.

A SIMPLE CALORIMETER FOR HEATS OF FUSION

Research Paper No. 607 which will be published in the October number of the Bureau of Standards Journal of Research describes a vacuum flask with a thermoelement used by the Bureau as a simple calorimeter for measuring heats of fusion quickly and economically, with an accuracy of a few percent. Heats of fusion, with estimated uncertainties are given for pseudicumene, hemimellitene, mesitylene, mesitylene (β), *o*-xylene, and *m*-xylene. Hemimellitene was found to have two transitions below the freezing point, and the heats of transition for both are given.

COMPOSITION AND THERMAL EXPANSION OF SOME SODA-LIME-SILICA GLASSES

Data were given in Technical News Bulletin No. 176 (December 1931) from which one can compute, approxi-

mately, the "critical" and softening temperatures, and also the total linear expansion to those temperatures, of 33 soda-lime-silica glasses. Since that report 16 additional glasses were made and their expansions were determined by the interferometer method, as in the previous case. The compositions of the new glasses were in the same range as those first studied—that is, the silica content varied from about 52 to 80 percent, the balance being either soda, or soda and lime, but the lime did not exceed 16 percent.

A simultaneous solution of all the data obtained on the 49 glasses shows that the linear expansions of any of these glasses, expressed in microns per centimeter, can be computed with reasonable accuracy (the maximum variation being 2.5 microns) from—

$$E=aA+bB+cC$$

in which E is the total linear expansion for any temperature range between 25° and 475° C.; A, B, and C represent the percentages of silica, soda, and lime, respectively; and a, b, and c vary with temperature as follows:

$$a=0.000222t$$
$$b=0.002826t+0.00000387t^2$$
$$c=0.001422t$$

in which t equals $T-25°$, T being the temperature at which expansion is computed, and is, in general, less than 475° C.

THERMAL EXPANSION OF VITREOUS ENAMELS

The thermal expansion characteristics of vitreous enamels are commonly expressed in terms of coefficient of expansion. It is a well-known fact that the temperature-expansion curves of enamels are not straight lines, and hence that the coefficient of expansion for a given enamel varies according to the temperature range in question.

Data obtained with the interferometer on a group of commercial type ground coats of systematically varying composition indicate that the expansion characteristics of these enamels may be expressed in terms of two constants which are applicable throughout the entire range from room temperature to critical temperature, or any part of it. Thus: $E=a(T_1-T_0)+b(T_1^2-T_0^2)$ where E is expansion per unit length, T_1 and T_0 are the limits of the temperature range involved, and a and b are constants characteristic of the enamel.

In an illustrative case, when T is expressed in °C., $a=8.35\times10^{-3}$, and $b=7.19\times10^{-5}$. E is then the linear expansion in microns per centimeter between the temperatures T_0 and T_1. The mean coefficient of linear expansion in a given temperature range may, of course, be obtained by dividing E by (T_1-T_0).

The constant a represents the "instantaneous" rate of expansion at 0° C., and the constant b represents the acceleration in expansion with respect to temperature. The formula rests upon the finding that this acceleration is a constant for each of the enamels studied.

A MULTIFREQUENCY AUTOMATIC RECORDER OF IONOSPHERE HEIGHTS

The importance of the Kennelly-Heaviside layer (ionosphere) in radio transmission, as well as in the general study of the atmosphere, has led to an intensive investigation of its characteristics both in this country and abroad. In America a number of observers have employed the pulse method of Breit and Tuve, using a radio transmitter, receiving set, and galvanometer oscillograph with photographic attachment. Short pulses of radio frequency energy are transmitted and the time required for the energy to go up to the ionosphere and back is recorded by a galvanometer oscillograph. This time interval is a measure of the "virtual height" from which reflections come. The procedure in previous work has been to record the changes in height for one frequency over a period of time, or to record the height as the frequency is changed by steps. Where information is desired over a band of frequencies the method previously employed requires considerable time and labor, and since changes in the ionosphere are often quite rapid, important details are likely to be missed. Critical effects are often observed for very small changes in frequency, so that a system that will give a continuous and rapid frequency variation with automatic operation is more desirable.

In the Bureau of Standards Journal of Research for October (Research Paper No. 608) a system is described which employs the method of Breit and Tuve with modifications which permit automatic recording and the shifting of the transmitting and receiving set continuously from 2,500 to 4,400 kilocycles at the uniform rate of 200 kilocycles per minute.

Records are presented which show the characteristics for different times of day and night. In the daytime dur-

ing the period of these tests three strata were usually indicated in the ionosphere. For the lower range of frequencies reflections come from the E region with a virtual height of around 120 km. As frequency is increased the waves pass through the E layer and are returned from the F_1 layer with virtual heights in the order of 200 km. The freqnecy for which this transition takes place varies with time of day and with season. In the middle of the day during these tests this critical frequency was in the neighborhood of 3,000 kilocycles, while the critical frequency for passing through the F_1 to the F_2 layer was usually between 3,800 to 4,100 kilocycles. The F_2 layer shows virtual heights of 280 km or more. It has been shown by others that the square of the critical frequency for any layer is proportional to the maximum ionization in that layer. Of particular interest is the character of the change observed when passing from one stratum to another as the frequency is increased. Although at times, when passing from E to F_1, reflections may drop out completely for a short interval, frequently the curve is continuous and the time retardation will reach a high value just before the appearance of the F_1 reflection. When passing from F_1 to F_2 the virtual height frequently reaches 800 or 900 km. As evening approaches reflections no longer come from the E layer for the frequencies 2,500 to 4,400 kilocycles and the long retardation between F_1 and F_2 becomes less pronounced. By sunset the curve is almost straight and there is little change of height with frequency. Later at night the highest frequencies cease to be returned and long retardations again occur. The phenomenon of double refraction is in evidence at this time.

Preliminary results have been presented with the view of indicating the possibilities offered by this method in the study of radio transmission and physical properties of the upper atmosphere. It is believed that records of the type shown give a more complete picture than it has been possible to obtain by methods previously used.

PERFORMANCE TESTS OF RADIO SYSTEM OF LANDING AIDS

Additional tests and demonstrations at the Newark Municipal Airport, Newark, N.J., since the publication of Technical News Bulletin No. 193, indicate the complete practicability of the Bureau of Standards radio landing system developed to assist aircraft in making safe landings under conditions of zero visibility. The first stage of development of this system was described in Research Paper No. 238, published in 1930. In Research Paper No. 602, which will appear in the October number of the Bureau of Standards Journal of Research, details are given of the final stage of the work, comprising the engineering redesign of the system to meet the requirements of practical use. Complete details of the equipment are given, as well as reports of performance tests. During the 2 months of tests, besides making a large number of hooded landings, it was possible to fly at all times when the scheduled air-mail and passenger airplanes were on the ground because of fog. The operation of the system was demonstrated in the air to many engineers and officials, as well as to nearly 100 air-transport pilots. Perhaps the most striking demonstration was a completely blind flight from College Park, Md., to the Newark Airport on March 20, during which radio was the sole means used for navigation and for landing.

DEPOSITION OF CHROMIUM FROM SOLUTIONS OF CHROMIC AND CHROMOUS SALTS

During the past few years, chromium plating has been extensively applied wherever a bright, tarnish-resistant surface is desired on metals; for example, in the automobile industry. The solutions now used for this purpose consist essentially of chromic acid. The electrical efficiency of plating from this type of "bath" (plating solution) is low, and it is difficult to plate irregularly shaped articles with a uniformly bright deposit. In spite of these difficulties, good plating is done, largely as the result of ingenuity in conducting the plating operation.

It would be highly desirable to obtain a chromium plating bath that would have a higher efficiency, a wider range for bright deposits, and a good "throwing power", that is, ability to plate into recesses. In a search for such a bath the Bureau has investigated other types of chromium solutions including chromic sulphate, chromic fluoborate, and chromous sulphate. The results, as set forth in Research Paper No. 604 to be published in the October number of the Bureau of Standards Journal of Research, showed that while it is possible to ob-

tain bright deposits from these baths, they are inferior in all the above respects to the chromic acid bath. With existing knowledge, there is very little prospect of developing a bath that will be superior to the present chromic acid bath.

UTILITY OF THE SPARK TEST AS APPLIED TO COMMERCIAL STEELS

The stream of sparks produced when a piece of steel touches a rapidly revolving grinding wheel is a familiar sight. If a trained observer protects his eyes with colored glasses and observes in detail the appearance of these spark streams he can see distinguishing characteristics which often allow him to separate one type of steel from another. Research Paper No. 605, which will be published in the October number of the Bureau of Standards Journal of Research, describes a detailed study of the spark streams of a wide variety of steels.

Typical spark streams of plain carbon steels, a variety of alloy steels, including S.A.E. steels, nitrided steel, and cast iron, are described and illustrated. Definite spark-stream characteristics were found in the steels studied for each of the alloying constituents, chromium, manganese, molybdenum, nickel, tungsten, and vanadium.

A supplementary study was made of the appearance of the metal pellets collected from the spark streams of the various types of steel. The presence in the steel of chromium, molybdenum, silicon, or vanadium in some cases, imparts characteristics to the pellets which may aid in the identification of the steel. The results show that the spark test may be depended upon as a means for classifying steels into groups of similar composition, but cannot be successfully used for identifying an unknown steel.

On the basis of the data given by the combined spark tests and pellet tests a sorting chart has been prepared. This chart indicates the possibility of sorting by the spark and pellet tests over 2,100 combinations of 2 steels of a total of 2,500 possible combinations of any 2 steels in the chart.

THE SYSTEM LIQUID IRON-CARBON OXIDES

A demand for more uniform material, by the structural engineer, has required the steel manufacturer to keep the refining processes under close control. This in turn has demonstrated the need for fundamental data. In connection with this demand the Bureau has investigated the system liquid iron in equilibrium with mixtures of carbon monoxide and carbon dioxide. In these experiments a mixture of carbon monoxide and carbon dioxide of known composition and at one atmosphere pressure was passed over liquid iron maintained at 1,580° C. After approximately 90 minutes' exposure to the gases the liquid iron was allowed to freeze in the crucible and the resulting ingot was analyzed for carbon and oxygen. The data show that the product of the contents of carbon and oxygen, coexisting in liquid iron under these conditions, is 0.0025. This value is applicable for all carbon contents between 0.01 and 0.5 percent and for all oxygen contents between 0.005 and 0.3 percent.

Additional experiments under similar conditions on the system liquid iron-hydrogen-water vapor showed that the data obtained for both systems were in good agreement with data for the familiar water-gas reaction. For the complete account of this work Research Paper No. 606 in the October number of the Bureau of Standards Journal of Research should be consulted.

TESTS OF THEATRE PROSCENIUM CURTAINS

Many municipalities and a few States have enacted regulatory laws and have placed theatres and opera houses under police supervision because of loss of life in theatre fires. Most of these laws require an asbestos cloth curtain, or one of other incombustible materials, to close the proscenium opening between the stage and the auditorium, but many of the essential details are not given. The lack of information needed in formulating code requirements led to an inquiry by the Bureau into the fire-resistive properties of theatre proscenium curtains. After examination of the structure and operation of many installations in 3 cities, fire tests were made on sections of 6 different types of curtains of about one sixth the area of those usually installed in theatres. Two of these were steel curtains with asbestos board insulation on the stage side, and four were made of asbestos cloths. One curtain made of a single ply of heavy wire-reinforced asbestos cloth and another made of two plies of plain asbestos cloth of the best commercial

quality and usual weight, were both found to be deficient as barriers against smoke and fire. Curtains made of two plies of cloth with steel frames to hold the plies apart provided protection against a severe fire for a period of about 15 minutes. Both types of steel curtains gave protection for a half hour or more and indicated reliability for the protection of persons and property. Most auditoriums are so designed that an audience filling it can make their exit within 5 minutes, but proscenium curtains should give protection for a longer period, so as to provide the required margin of safety.

Flexible asbestos cloth curtains without the steel frame, when subjected to pressure from the stage side, were found to bind against the proscenium wall with serious probability of failure to close under fire conditions. Tests of the asbestos cloths from which the curtains were made showed that all suffer serious loss of strength after subjection to flame or high temperature.

The report of these tests will be published as Research Paper No. 603 in the October number of the Bureau of Standards Journal of Research.

DAMPNESS ON MASONRY WALLS

As mentioned in Technical News Bulletin No. 197 (September 1933), a letter circular (LC391) has been prepared on this subject and copies are now ready for distribution.

This letter circular enumerates the causes of dampness on the interior surfaces of masonry walls above grade. The conditions favorable to condensation on masonry walls are described. Inadequate protection of masonry from water collected on roofs or other horizontal or sloping surfaces is cited as a frequent cause of dampness. Relations between rainfall, wind velocities, and absorptive properties of masonry walls are found to indicate that occasional dampness should be expected when plaster is applied directly to the interior surface of ordinary walls 8 inches in thickness. Different types of colorless waterproofings are compared and methods for treating masonry are discussed. Specific methods are given for remedying dampness in masonry walls.

EFFECT OF WEAVE ON THE PROPERTIES OF CLOTH

The physical properties and the appearance of cloth depend to a great extent upon the weave. The strength, elongation, take-up, tear resistance, fabric assistance, air permeability, and texture are some of the properties which may be varied by changing the weave. For aeronautical cloths with rigid limits on the weight, the weave is an important means of obtaining some of the desired physical properties.

The textile section of the Bureau has made a systematic study of the effect of weave on the properties of the cloth. A series of 42 cloths was woven from the same cotton yarns in weaves comprising plain, twill, rib, mock leno, basket, sateen, and various combinations of these weaves. In general, a cloth which is closely woven yields the highest strength and the lowest tear resistance, while a cloth of the same weight which is loosely woven yields the lowest strength and the highest tear resistance. The factors which contribute to strength and tear resistance are enumerated and discussed.

Four cloths having high tear resistance were woven for experiments on rubberizing and on doping. In Research Paper No. 600, in the October number of the Bureau of Standards Journal of Research, the results of these experiments are given and compared with the properties of the untreated cloths and with the properties of the gas cell cloth and outer cover cloth which are used in airship construction.

TESTS OF IMPORTED REFINED SUGAR AT CHICAGO

Importations of refined sugars from Cuba are being received at a number of the inland ports. Chicago is receiving regular shipments of considerable magnitude. To facilitate the accurate testing of these sugars at the Chicago customs laboratory, the Bureau has tested and delivered a new Bureau of Standards type saccharimeter to that port. A member of the Bureau's staff visited the Chicago laboratory in connection with this work and at his suggestion exchange samples of the refined sugar are being received for control test.

RECOMMENDED COMMERCIAL STANDARD FOR MARKING GOLD-FILLED AND ROLLED GOLD-PLATE ARTICLES OTHER THAN WATCHCASES

A general conference held on September 21, 1933, at the United States Chamber of Commerce adopted a recommended Commercial Standard for marking all gold-filled and rolled gold-plate articles other than watchcases as a basis for promoting fair competition; to enable the consumer to make a di-

rect comparison of quality of gold-filled and rolled-plate articles; to establish a definite minimum quality for gold filled; to promote the sale of items of real quality; and to establish a better understanding between buyer and seller of gold-covered articles.

According to the standard, no articles may be marked gold filled or rolled gold plate unless they are produced by soldering, brazing, welding, or affixing by other mechanical means a sheet or shell of karat gold upon base metal, said sheet or shell of gold to be rolled, drawn, or pressed to the marked weight ratio before uniting with the base metal.

The recommended standard further requires that articles made by the above process shall be marked "gold filled" only when the quality is 1/20 10K or better. For example, "1/10 12K Gold Filled" means that the article consists of a base metal covered on one or more surfaces with a gold alloy of 12-karat fineness throughout the gold covering, said covering of gold alloy comprising 1/10th part by weight of the entire article exclusive of joints, catches, screws, and other exemptions recognized by the trade.

In the case of "rolled gold-plate" articles, the standard requires that articles marked "rolled gold plate" shall also be marked to show the proportional weight of the coating and the fineness designation.

In addition to the quality mark, it is further required that articles so made and so marked shall have applied thereto a registered trade-mark or name of the manufacturer, in order to fix responsibility for the quality mark.

The recommended Commercial Standard has been circulated to producers, distributors, and consumers for written acceptance, and if accepted by a satisfactory majority of production, it will, in the absence of active opposition, be made effective for new production on January 1, 1934.

NEW AND REVISED PUBLICATIONS ISSUED DURING SEPTEMBER 1933

Journal of Research[1]

Bureau of Standards Journal of Research, vol. 11, no. 3, September 1933 (RP nos. 593 to 599, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers[1]

(Reprints from June and July 1933 Bureau of Standards Journal of Research)

RP561. The compressometer, an instrument for evaluating the thickness, compressibility, and compressional resilience of textiles and similar materials; H. F. Schiefer. Price 5 cents.

RP562. The thermal expansion of refractories to 1,800° C; R. A. Heindl. Price 5 cents.

RP563. Fire tests of columns protected with gypsum; N. D. Mitchell. Price 5 cents.

RP564. The infrared arc spectra of manganese and rhenium; W. F. Meggers. Price 5 cents.

RP566. The viscosity of sulphuric-acid solutions used for battery electrolytes; G. W. Vinal and D. N. Craig. Price 5 cents.

RP567. Composition of grids for positive plates of storage batteries as a factor influencing the sulphation of negative plates; G. W. Vinal, D. N. Craig, and C. L. Snyder. Price 5 cents.

RP568. The freezing point of iridium; F. Henning and H. T. Wensel. Price 5 cents.

RP570. A new description and analysis of the arc spectrum of chlorine; C. C. Kiess. Price 5 cents.

RP572. Creep and structural stability of nickel-chromium-iron alloys at 1,600° F.; W. A. Tucker and S. E. Sinclair. Price 5 cents.

RP573. An international comparison of temperature scales between 660° and 1,063° C.; W. F. Roeser, F. H. Schofield, and H. A. Moser. Price 5 cents.

RP576. A 200-kilocycle piezo oscillator; E. G. Lapham. Price 5 cents.

RP577. The viscosity of optical glass; W. H. Wadleigh. Price 5 cents.

RP578. The present status of the standards of thermal radiation maintained by the Bureau of Standards; W. W. Coblentz and R. Stair. Price 5 cents.

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[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D.C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research $2.50 per year (United States and its possessions; Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents and $3.25, respectively.

RP580. Equipment for testing current transformers; F. B. Silsbee, R. L. Smith, N. L. Forman, and J. H. Park. Price 5 cents.

RP581. Phase synchronization in directive antenna arrays with particular application to the radio range beacon; F. G. Kear. Price 5 cents.

Technical News Bulletin[1]

Technical News Bulletin No. 197, September 1933. Price 5 cents. Obtainable by subscription.

LETTER CIRCULARS

It is the intent of the Bureau to distribute single copies of these mimeographed letter circulars on request only to those parties having special interest in the individual letter circular. Economy necessitates limitation in the number of copies issued. It is not the intent to supply parties with a copy of each letter circular issued during the month. Letter circulars are necessarily of a temporary nature designed to answer numerous inquiries on a given subject. Requests should be addressed to the Bureau of Standards, Washington, D.C.

LC389. Publications of the Bureau of Standards on X-rays.

LC390. List of weights and measures offices of the States and District of Columbia.

LC391. Damp masonry walls above grade.

[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D.C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research $2.50 per year (United States and its possessions; Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents and $3.25, respectively.

OUTSIDE PUBLICATIONS[2]

Judson, E. B., Low frequency radio-receiving measurements at the Bureau of Standards in 1931 and 1932, Proceedings, Institute of Radio Engineers (New York, N.Y.), vol. 21, p. 1354, September 1933.

The dental research fellowship at the National Bureau of Standards—A statement from the Research Commission of the American Dental Association of interest to dentists, dealers, and manufacturers, Journal of the American Dental Association (Chicago, Ill.), vol. 20, p. 1040, June 1933.

Mitchell, N. D., Tests of gypsum-encased steel columns, Engineering News Record (New York, N.Y.), vol. 111, no. 7, p. 195, August 17, 1933.

Waters, C. E., Blue dye as evidence of the age of writing, Industrial and Engineering Chemistry (Washington, D.C.), vol. 25, p. 1034; September 1933.

Mease, R. T., Adsorption of alcohol by fibrous materials, Industrial and Engineering Chemistry (Washington, D.C.), analytical edition, vol. 5, no. 5, p. 317; September 1933.

Herschman, H. K., and Basil, J. L., Tin-free leaded bearing bronzes, Metal Industry (London, England), vol. 43, p. 219; September 8, 1933.

de Sveshnikoff, V. V., Abrasive grain sizes studied, Abrasive Industry Cleveland, Ohio), vol. 14, no. 10, p. 9; October 1933.

McBurney, J. W., and Lovewell, C. E., Strength, water absorption, and weather resistance of building bricks produced in the United States, Reprint from Proceedings, American Society for Testing Materials (Philadelphia, Pa.), vol. 33, part II, 1933.

[2] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

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